sensitive than the fovea, Kirschmann finds it more sensitive by about one seventh, and Fick finds it ten to fifteen times more sensitive. The experiments of Fick seem to us to have been conducted with much the most acumen and with the most careful avoidance of sources of error. In the first place, his object was seen by transmitted light, instead of by reflected light. A small piece of porcelain was lighted up from behind, and the amount of light allowed to fall upon it was regulated by a diaphragm. Both the other observers used Masson disks, and measured the amount of white necessary to add to the black to make the disk just perceptible; their source of light was the windows of the room, or the windows somewhat darkened by curtains. But every one knows that it is almost impossible to hold two strips of paper, near together even, in front of several windows, in such a way that they are equally lighted. Kirschmann, it is true, had windows looking upon a gray wall, and allowed for the contrast effect of his background, but neither of these precautions was taken by Treitel. The results of Fick and Kirschmann are not really incongruous, for Kirschmann worked by day-light and Fick in the dark; and even Treitel found that the supposed superiority of the fovea was almost evanescent in a diminished light.

In the second place, it was discovered by Schadow that the presence of a bright image on the fovea renders the lateral parts of the retina much less sensitive than they would be without it. Treitel maintains that it is impossible to steadily fixate a point when there is nothing to look at; that may be so in general, but if there is a bright point above and one below, it is not difficult to keep the eye steady half way between them, and this is the device which Fick made use of. Treitel finds the retina one tenth as sensitive at a distance of thirty to forty degrees from the center in daylight, but half as sensitive in a faint light. The difference he attributes to the more ready fatigue, and hence the slower adaptation of the center. But it has never been shown that the center is more easily fatigued than the periphery. This is really a case of question-begging. It can only be more readily fatigued by being more sensitive, and whether it is more sensitive or not is the very question at issue. A supposed fact is not rendered more probable because it can be explained by something else which is a mere re-statement of the fact itself. Moreover, a common experience shows that the center is less subject to fatigue than the periphery; any one whose eyes have been pained during sickness by the presence of a light in the room knows that it can be much more easily endured by looking directly at it.

On the whole, the subject seems to be left at present in a good deal of confusion. The former observers who agree with Treitel are Rupp, Exner, Dobrowolsky and Gaine, Chodin, and Bull; those who disagree with him are Aubert (but he thinks the adapted eye is about the same throughout), Schadow, Charpentier, and Butz. But the experiments of Fick, as we have already said, seem to us to carry more conviction with them than any of the others.

C. L. F.

Ueber intermittirende Netzhautreizung. BELLARMINOW. Arch. f. Ophth. XXXV, 1, p. 25.

Kirschmann has just called attention to the fact that two sensations furnished by a rotating disk are fused into one sensation with less velocity of rotation at the fovea than in the periphery. Bellar-

minow has made an extended series of experiments on this subject. Exner had already noticed (*Pflüger's Archiv*, Vol. XXXII) that the periphery is more sensitive to change of brightness than the center, and that it has a special tendency to interpret change of brightness as due to motion. Hence it detects small motions more readily. Bellarminow regulated the intensity of the light by the width of a slit, produced intermittance by a rotating disk, determined the velocity of its rotation by the pitch of its musical note, and used the spectrum for experiments in color. In a faint light the rapidity of rotation necessary to cause flickering to cease was only two-thirds as great at the center as in the periphery. In strong light the difference was not so great. Blue and violet gave the same results as white light, but green, and still more yellow, fused at high intensities soonest in the periphery. The size and shape of the object looked at seemed to have no effect on the result. The author attributes these results to the greater intensity but shorter duration of after-images in the periphery. He does not make it plain how that, if it were true, would be an explanation. Nor does he give anything to show that the greater sensitiveness of the periphery is not a quality of cortical instead of retinal vision. It might well be that we had the habit of giving such instantaneous and undivided attention to indications of motion in the lateral field of vision as would be quite sufficient to account for a greater power of detecting it. There is at present, of course, no sure way of distinguishing between the retinal and the cortical divisions of the visual process.

C. L. F.

Physiologische Studien über die Orientirung, unter Zugrundelegung von Yves Delage Etudes expérimentales sur les Illusions statiques et dynamiques de Direction pour servir à déterminer les Fonctions des Canaux demicirculaires de l'Oreille interne. HERMANN AUBERT. Tübingen, 1888, pp. 122.

The fact that nearly all the other works on the subject of the functions of the semi-circular canals were either written in German or have already been translated into German (the brief papers of Laborde and Crum Brown form the only exception) has induced Aubert to translate this work of Delage's, which appeared originally in the *Archives de Zoologie expérimentale*, 1886 (see review in this JOURNAL, Vol. I, p. 179). He takes occasion to add many foot-notes of his own, chiefly confirmatory of Delage, in view of the fact that his own complete investigations on the subject will not be ready for publication for some years to come.

Since Delage's articles were written, the question whether the semi-circular canals are or are not organs for the perception of rotation has been set at rest by the admirable work of Breuer in producing determinate rotations of the head in doves by electrical stimulation. (See Pflüger's Archiv, Bd. 34, p. 135, reviewed in this JOURNAL, Vol. II, p. 332.) But in what way the sensation is excited still remains an unsettled question. Breuer produces the compensatory motions of the head (and hence, by inference, the sensations) by drawing out the endolymph with a piece of blotting-paper, but this does not prove that an actual motion of the endolymph must take place every time that the sensation is produced. A retarded flow of liquid in large glass tubes made in the shape of the canals takes place in a way that would exactly explain all the phenomena, but most writers